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A Century of Milk

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FOREWORD

Since its founding eighteen years ago, BORDEN'S REVIEW OF NUTRITION RESEARCH *has adhered to an editorial policy summed up in its title: the publishing of review articles on nutrition research by recognized authorities in the field. In this issue, for the first time, we are departing from that policy, in content and style. The occasion is the 100th anniversary of the founding of The Borden Company by Gail Borden, inventor of condensed milk and "father of the modern dairy industry."*

Great and dramatic events have taken place within the industry in the past century. We hope to record them here, with the perspective that time and the significance that history have given them. This is not a definitive article, in that no one segment of a history has been exhausted; it is not a comprehensive article, in that not all men and events in a history have been covered. We hope, however, that we have succeeded in making it an objective article, wherein the man is in proportion to all other men, the event in proportion to all other events, and the total impression, if not deep, at least even.

A Century of Milk

"The people who have achieved, who have become large, strong, vigorous people . . . who have the best trades in the world, who have an appreciation for art, literature, and music, who are progressive in science and every activity of the human intellect are the people who have used liberal amounts of milk and its products."

So spoke the eminent dairy scientist and nutritionist, and a discoverer of Vitamin A — E. V. McCollum. An extravagant claim? Was this the alchemists' "elixir of life," deLeon's "fountain of youth?" From among all the substances that have fed man, from among all the stimuli that have bestirred him, McCollum chose milk as the common substance for all times and all races. The facts of history would seem to bear him out.

For 400 centuries man has been aware of milk's value; only in the last of these has he come to understand it. Until a century ago, milk was a paradox: A substance to sustain life, it sometimes brought death. Its very whiteness was at times a perverse symbolism. But in the past hundred years, a partnership of science and industry has given America leadership as the source of the world's safest and most abundant milk supply. Science and industry together have resolved nature's paradox, and made of milk a friend of man.

This is the story of men and events during those fruitful and exciting years.

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Milk must be the oldest food known to man, since none except perhaps Adam and Eve began life without it. Certainly, man has always been absorbed by it; one of the earliest "writings," the cave-paintings at Lascaux, shows cows heavy with milk, and the Biblical writers saw fit to mention the substance 44 times in the Old Testament, almost always in pleasant metaphorical connotation. Milk then, as now, was almost life itself.

Yet until a few centuries ago, man used milk more from instinct than from knowledge. If milk was a mystery, however, it was mystery that he could not long ignore nor accept. Aware of the benefits of milk, he began seeking ways of preserving it or, more likely, he uncovered those methods by accident. Soured and fermented milks were his first successes. One must wonder now at the reaction of that Arabian desert tribesman who, lifting a goatskin from his camel's back for a drink of milk after a long, hot ride, first swallowed a mass of curds. Would he have understood that it was the rennet in the lining of the goat's stomach that produced the world's first cheese? The Tartars in the 13th century could hardly have explained, either, the action of the sun in turning milk into compact, nutritious, and easily portable pastes; nor could the Hindus, 2,000 years before Christ, have accounted for the product they made from milk, that we know as butter.

Humble men could wonder and bold men could guess at the mysterious behavior of milk, but not until the day in 1679 that Leeuwenhock first peered into his crude microscope, and uncovered a new world of living things, did science enter the world of dairying. Leeuwenhock was unaware of his role, as were his contemporaries and many of those who followed. But in his studies of "animalcules" and yeast, and in his observations of red and white blood cells and the compound eyes of insects, he also encountered "bacteria." It was a discovery that was subsequently to engage some of the great minds of science, and eventually to create a major breakthrough in dairy progress: sanitation.

In 1810, a one-time French confectioner, Nicholas Appert, published a treatise entitled "The Art of Preserving All Kinds of Animal and Vegetable Substances for Several Years." Its appearance attracted considerable attention, for only a year before the author had been awarded a prize of 12,000 francs by the Emperor of France for his method of applying heat to food in a sealed container — the process known as canning. Appert, apparently, was aware of his method's virtues and cognizant of its significance, but ignorant of the natural laws that made it work. He outlined his "Art" for some 50 foods, including milk, and for each the essential step was boiling. He had killed bacteria by heat sterilization.

Ground for dairy progress in the next four decades was to be tilled by inventors, rather than scientists: DeHeine in 1810, with a preserved milk with sugar added; Edward Howard in 1813, with his invention of the vacuum pan; William Newton in 1835, with an evaporated milk; Grunaud and Galais in 1850, with yet another evaporated milk, this one reduced to one-fourth the volume of whole milk. Then, in 1853, another man appeared, different from the rest. A strange mixture: part businessman, part inventor, part scientist, part dedicated humanitarian. His name was Gail Borden.

Born in Norwich, N. Y., in 1801, and descended from Roger Williams and two signers of the Declaration of Independence, Gail Borden had been surveyor, teacher, and newspaper editor before turning his talents to invention. A "locomotive bath house" and a " terraqueous machine," the latter a bouyant prairie schooner with sails, had earned him only scorn, but a preserved meat biscuit of his devising won a gold medal at the Great Council Exhibition of 1851 in London. No one knows when Borden began experimenting with preserved milk; success, in the eyes of the hindsighted, would seem to be a product of environment. Some say he first explored the subject as a young schoolteacher in Mississippi; others, that it caught his interest while working as a customs' collector at Galveston, Texas. Chronologically, Borden's attempts to produce a wholesome milk of good keeping qualities would seem to date from his return from London in 1851. It is known that he was distressed by the deaths of infants aboard ship, who were unable to get milk because the two cows in the hold were sick. And Borden's whole existence for the next year and a half, his journals show, was devoted to experiments with milk, to the detriment of his family's welfare and the commercial success of his meat biscuit.

Early in 1853, Borden left New York City to investigate reports of the unusual food-preservation methods of the Shaker community at New Lebanon, N. Y. The Shakers, inventive and progressive people, had adapted Howard's vacuum pan to their wants, producing cooked herbs and fruits of unusual flavor and excellent keeping qualities. Impressed, Borden borrowed one of the pans for his experiments with milk; shortly afterward, he had one constructed to his own requirements. By early spring of 1853 he had produced a product that amazed his friends and satisfied himself, and in May of that year he applied for patents for the process.

Borden claimed no originality in producing what he called condensed milk. But he did maintain, and insisted throughout four patent applications, that his process, because of its use of low heat "in vacuo," prevented the "incipient decomposition of milk." Doctors and health authorities had become increasingly aware and fearful of the effects of contaminated milk; Dr. R. T. Trall in 1853 had stated that it was the "unanimous declaration of medical men that thousands of children annually sicken and die in New York City from the effects of bad milk." Now, though, the lines were being drawn; science and industry were joining partnership to resolve nature's paradox. In Paris, a 34-year-old scientist, Louis Pasteur, was setting up his laboratory in the Ecole Normale. And in Washington, D. C., scientist Robert Macfarlane, editor of *Scientific American,* supported the unusual claims of Borden's fourth and successful patent application. Milk, said Borden, like blood "is a living fluid, and as soon as drawn from the cow begins to die, change, and decompose." Dramatic, perhaps, but not far from the truth as we know it today.

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Gail Borden's invention of a practical condensed milk earned for him the title of "father of the modern dairy industry." His product brought the country dairy to city streets and, for the first time, put pure and wholesome milk within the reach of all. The fact that milk was produced in the country, of course, was no guarantee of its purity or wholesomeness. Adulteration? Well, a little water never hurt anyone, and, besides, it was mostly melted ice.

Borden understood that to end with a good product, he would have to begin with good milk. When, in 1857, he opened his first condensery in Litchfield County, Conn., he scoured the surrounding countryside for dairies that, he felt, with proper supervision, could produce clean milk.

The farmers did not like this meddling, crochety, finicky old man, but he paid well and promised a year-round market for their milk. Some of his demands seemed downright silly: Udders were to be washed thoroughly in warm water before milking; no milk from cows that had calved within twelve days; no milk from cows fed on turnips ("it might make the milk taste"); barns were to be swept clean; wire-cloth strainers had to be scalded and dried morning and night. He was equally demanding upon himself and his co-workers at the factory. Each batch of milk was inspected upon arrival, turned back if not sweet-smelling, or if its temperature was above 58 degrees. Employees were arrayed in surgical

splendor: white caps, white gowns, white gloves; and the plant itself glistened like a modern operating room in its coat of whitewash. Yet all this was not enough. "It is not enough," wrote Borden, "to have good milk and good apparatus; everlasting vigilance and the most exemplary care are . . . indispensable."

Borden laid the foundation for dairy and plant sanitation practices that today are commonplace. But in the 1850's he stood almost alone. In New York City, less than a hundred miles from the scrubbed barns and richly-fed cows of Litchfield County, cholera infantum was taking the life of every fifth child in its first year. Small wonder. Here the "dairies" were ill-managed, unkempt brewery annexes, where cows were fed on fermented mash. Housewives marvelled at the richness of the product dispensed from pushcarts along the streets, and wondered as their children grew sickly. Ingenious "processors," it appeared, had uncovered the secret of synthesis of milk: Water for volume, chalk for whiteness, molasses for body, an occasional egg for "creaminess."

Not all New York City's milk came from brewery dairies. At the turn of the 19th century, an obscure entrepreneur had filled in an area of the swampy meadows across the Hudson River in New Jersey, and established a model dairy to supply New York, and in 1841 the first milk from Orange County, N. Y., rolled into the city over the new Erie Railroad. In May, 1857, Gail Borden began selling his strange new condensed milk. But for most of New York's millions, or, rather, for its children, the daily milk was still swill milk.

Knowing and thoughtful people were alarmed, as were the ignorant and the querulous. As early as 1835, the secretary of the New York City Temperance Society was zealously denouncing brewery dairies, not for the quality of their product, but because they were allegedly dispensing alcohol to infants through milk. In 1848 a committee of physicians appointed by the New York Academy of Medicine investigated the Temperance Society's charges, and found them false: there was no alcohol present. The committee, though, did point out the poor quality of swill milk, and with the appearance of Borden's condensed milk heartily endorsed it as "hitherto unequalled for purity, durability and economy in the annals of the Milk trade."

Thus progress was being made. In 1856, the city of Brooklyn, then separate from New York, passed an ordinance on the keeping of cows, and in that same year Boston appointed its first milk inspector. It was a crusading newspaper editor, however, who first aroused the public from its apathy toward swill milk. In 1858, Frank Leslie, through his *Leslie's Illustrated Newspaper,* launched a series of devastating articles attacking brewery dairies and their owners. The term "illustrated" was no misnomer. Brewery bosses were sketched with Cruikshankian cruelty; barns and cows, with shocking realism. There was prose to match, summed up in the blunt declaration that this was "milk murder."

The shock treatment had its effect, and one by one the brewery dairies closed, until a cow on Manhattan Island was almost as rare as an Indian. In big cities everywhere, confidence in processors and dairymen increased as the milk supply grew purer and safer. Integrity had come to the dairy industry.

One of the most significant developments during the past century has been the emergence of the dairy sciences. From ancient and from new sciences, wherever wisdom could be found, inquisitive men accumulated bodies of knowledge with particular applications. This is the explanation for some of the great advances in the dairy industry, particularly in the period after 1870. Leeuwenhoek's discovery of spermatozoa in 1679, and Mendel's postulation of the laws of heredity almost 200 years later, made possible the breeding of high-producing cows through artificial insemination.* The wine industry of France, no less than the dairy industry of America, is in debt to Pasteur for pasteurization. The concept of "vitamine" evolved from Eijkmann's and Grijons' studies with rice.

Men not of science have played a role, too, in the advancement of dairying techniques and processes; men like Philanthropist Nathan Straus, in his dedicated struggle for pasteurized milk, or Druggist Harvey Thatcher, whose invention of the milk bottle in 1884 made the jar and pail, pitcher and pan obsolete as containers for milk.

One of the most modern of sciences, and one of the most important from the standpoint of its contributions to productive human life, is that of nutrition; an outgrowth and refinement of one of man's oldest sciences: chemistry. It was the science of nutrition that was to confirm that milk is, indeed, "nature's most nearly perfect food," for in this one pleasant-tasting product food chemists were to find a good balance of nutrients, an abundance of high quality protein, and a plentiful supply of minerals and vitamins.

A century ago, an impressive mass of chemical knowledge about food had already been gathered. Largely missing was its proper application and its significance. Lactose was discovered in 1747; cholesterol, in 1789; iodine, in 1811; the amino acids, glycine and leucine, in 1822. The term "protein" was coined by Mulder in 1838 for what he believed to be "the most important of all organic substances." But, until the later decades of the nineteenth century, food was looked upon as merely fuel for the body, just as coal was fuel for an engine. In fact, there was no distinction in terminology; metabolism of those complexes of protein, lipids, carbohydrates, and mineral matter was measured by the calorie: the heat (or energy) required to raise one gram of water one degree Centigrade.

But in their work with this growing number of substances, scientists found that they had discovered no hidden passage to nature's food secrets. Instead, it was a maze.

Nutrition, essentially, is the use of a balanced diet. Some races have achieved well-balanced diets, despite environment, by instinct or by accident. Undoubtedly there are races now extinct because they overrode their instincts, became careless or lazy, perhaps "over-civilized" in their use of food.

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*But it would be another 66 years — 1931 — before mass breeding of cows by artificial insemination would be developed, by the Russians. The first artificial breeding cooperative was established in Denmark in 1936. Enos Perry organized the first such cooperative in the United States in 1938, although artificial insemination of cows was being practiced in a few herds at that time.

Man has lived through history on three broad types of diets: the carnivorous, the Oriental, and the Western. Each, properly used, has been surprisingly adequate, producing strong, vigorous and well-developed peoples. Only when he has veered from the rather well-defined limits of each has man suffered.

The healthy, red-blooded American probably considers himself the carnivorous type whenever he orders a two-inch steak. One wonders what he would think of a steady diet of glandular organs, nervous tissue, and soft bones, yet these items produced the tall, straight, keen-sighted American Indians who roamed the plains of the West a century ago. Cereals, legume seeds, tubers, and green vegetables principally constitute the Oriental's diet, and while it may fall short of the optimum, it has sustained a race with a long and productive history.

The Western diet, with the best features of the carnivorous and Oriental and the addition of liberal amounts of dairy products, has achieved the highest point in the well-being of man. But until a half-century ago, one could have found everywhere hunger in the midst of plenty, and sickness where reason said it should not be. These were "'hidden hunger," and the sickness of malnutrition.

The first major breakthrough in the battle against these elusive forces came in 1911, when Funk introduced the concept of "vitamine" to describe the missing organic factors necessary to cure beriberi and scurvy. Then, in 1913, McCollum and Davis, at the University of Wisconsin, and, simultaneously, Osborn and Mendel, at Yale, discovered the first of these organic substances. They had been studying the nutritive qualities of various fats for rats being fed purified diets. The superiority of butterfat over other fats McCollum attributed to Vitamin A. Steenbock, in 1919, associating the yellow color of fats with the Vitamin A effect, demonstrated the Vitamin A activity of carotene, the first of some 20 substances known as the carotenoid pigments, but not until two years later was it finally established that carotene is converted to Vitamin A in the body. Meanwhile, McCollum and E. B. Hart were demonstrating the place of this vitamin in the diet: without it, degenerative changes in nerve tissue; with it, a striking improvement in night vision.

This, then, was the first of the "micro-nutrients" to be clinically identified, the missing "accessory growth factors" that, in the next 40 years, to name them, would exhaust four-fifths of the alphabet. Advances in nutrition swept in a whole army of proselytes for milk, original disciples and some converts. Professor H. C. Bryant, of Columbia University, after studying the diets of some 100 New York City families, publicly recommended a 200 per cent increase in milk consumption. Professor R. M. Washburn, of the University of Minnesota, called milk "liquid meat." Dr. McCollum, in 1919, advocated a quart of milk a day throughout life for every individual, and the National Committee on Milk Standards stated flatly that "milk is the one food for which there is no satisfactory substitute."

These men and groups were not speaking as prophets, yet discoveries and researchers in the subsequent 40 years would have added only wisdom to their

words. Not until 1922 would the "sunshine vitamin," D, be isolated and defined, although for 125 years cod liver oil had been known to cure rickets, and Palm, as early as 1890, had suggested that the disease is caused by a deficiency of sunlight. It would be 1930 before chemists would establish the multiple nature of Vitamin B, later making it possible for them to calculate a "periodic table" of the B complex by which functions could be postulated before even the vitamins themselves were isolated. In milk, too, would be found vitamins like E, K, H, pantothenic acid, choline, and inositol, whose functions could be determined or surmised but for which no recommended daily allowances have even yet been made.

But vitamins, for all their novelty, did not wholly divert the attention of nutritionists from the behavior of the older members of the chemical food groups—the carbohydrates, fats, proteins, and minerals. And as they discovered new substances, and learned more about the older ones, biochemists began to unravel another of nature's mysteries: the complex interaction of chemicals within the body. Evidence began to accumulate that milk acted in defiance of the physical law that the whole can be equal only to the sum of its parts. Researchers found, for example, that the body can convert the amino acid, tryptophan, into the vitamin, niacin, and the carotenoids into Vitamin A. Milk, a minor source of niacin, is a good source of tryptophan. Milk fat helps the body to convert more efficiently the carotenoids of fruits and vegetables into Vitamin A. Thus did Dr. Henry C. Sherman come to call milk one of nature's "wholes."

Although the term protein had been coined as far back as 1838, and two of the amino acids had been discovered in 1822, up until 1918 and the work of Osborne and Mendel, the proteins of milk were considered to consist of only three entities: casein, lactalbumin, and lactoglobulin. Casein was the first of these to be proved heterogeneous, with the eventual fractionation of at least three components. Modern equipment, and modern techniques of analyses have established the presence of a score of amino acids, and nutritionists have broken these down into "essential" and "non-essential" in terms of the dietary needs of the body. The dietary "essential" amino acids, ten in number, cannot be produced by the body, and must be supplied in the needed form in the foods eaten. The "non-essential" amino acids are so important that, in the words of Du Vigneaud, "the body has learned how to synthesize them."

Constant advances in biochemistry were revealing new manifestations of the incredible complexity of milk, and progress in knowledge of nutrition, keeping pace, found reasons for this complexity. Sherman and Pappenheimer, in 1921, established the need of phosphorus in the utilization of calcium in the body. Their studies later fixed the role of Vitamin D in correcting the effect of faulty ratios of these minerals. Biochemists uncovered a dozen major acids, and a great number of minor ones, in milk fat, and nutritionists established which were essential in the diet. In 1889, Tanret identified ergosterol, an alcohol that, when exposed to ultraviolet rays, produces Vitamin D. In 1924, scientists discovered

that cows fed on irradiated feed would produce milk richer in Vitamin D. In 1932, pure crystalline Vitamin D made its appearance under a biochemist's microscope.

In their synthesis of vitamins, scientists brought nature's most nearly perfect food closer to perfection, and gave nutritionists another weapon in their battle against "hidden hunger" and deficiency diseases. In the decade between 1932 and 1943, the partnership of science and industry was to advance milk from a product which, nutritionally, was as nature made it, to one fortified with the minimum daily adult requirements of all essential vitamins except Vitamin C.

Vitamin-fortified milk was produced experimentally in the mid-twenties, following the announcements made independently by Dr. Alfred F. Hess and Professor Harry Steenbock in 1924 that anti-rachitic properties could be imparted to certain foods by irradiation with ultra-violet light. Liquid Vitamin A concentrates, in the form of carotene, appeared about 1930, but their use was confined principally to milk flavorings such as chocolate syrup. Walker-Gordon Laboratories, in the summer of 1931, introduced a certified fluid milk whose Vitamin D content had been increased by the feeding of irradiated yeast to cows. The Borden Company, late in 1932, delivered the first commercially-available irradiated Vitamin D milk to a housewife in Detroit.

The movement toward industry-wide fortification of milk, however, dates from the Vitamin D milk program initiated in 1933 by the American Medical Association Council on Foods and Nutrition. An American Medical Journal editorial in that year declared: ". . . the incidence of rickets is still too great and will continue to be until some cheap, generally available, agreeable source of vitamin D is provided. Vitamin D milk seems to offer promising possibilities of meeting these requirements."

The evaporated milk industry, backing the program, in 1934 offered a product with a Vitamin D content of 135 USP units per pint. By 1945, fortified evaporated milk, now with 400 USP units of Vitamin D per pint, was universal. The Borden Company, in 1943, introduced its multi-fortified fresh milk, with seven essential vitamins and minerals added. The milk statutes of several states, prohibiting multi-fortification, have prevented, however, the sale of the product nationally.

One of the more significant nutritional developments in the past twenty years has been phenomenal growth in the consumption of the nonfat solids of milk, particularly in dry form. For almost 40 years from its introduction as a commercial product, nonfat dry milk had found its principal outlets in feeds and, to a lesser extent, the bakery and candy trades. World War II, with its world-wide demand for fats and oils, cut sharply the available supply of butterfat. An intensive and effective campaign, led by the U. S. Department of Agriculture, to educate consumers in the uses and benefits of nonfat dry milk solids, coupled with the introduction of the product in consumer-sized packages by dairy companies, brought a swift rise in acceptance of the powder in the home. Fluid skim milk,

too, in the postwar years, won an increasing number of adherents, multiplied when the industry first fortified, then modified, the product.

Throughout these fruitful decades of advancement in the science of milk, an art, too, was playing a vital role: the art of communication. The technical article in a scientific journal, and the folksy columns of the local newspaper, were together bringing the story of milk and nutrition to millions. Common bonds of interest led to the formation of a score of dairy organizations and, through them, to the creation of articulate and informed spokesmen for all branches of the dairy industry. The great discoveries of the past century in milk chemistry and nutrition have been immeasurably enhanced by their being broadcast to the world.

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All knowledge gained in the chemistry of milk throughout a hundred years did not detract from, indeed, helped to confirm, Gail Borden's quaint dictum that milk is a "living fluid." Matching throughout this period the delight of biochemists and nutritionists in the virtues of good milk was the concern of bacteriologists and health authorities with the dangers of bad milk. The departure from the scene of swill milk dairies in the early 1870's, and the arrival of country milk, did not put an end to milk-borne diseases. Condensed milk was an assured source of safe milk, and would remain the principal one until the invention of evaporated milk by John Meyenberg in 1884. A satisfactory fresh milk supply would have to wait upon the outcome of a battle that was to be fought for many years, one in which eventually scientists, inventors, farmers, businessmen, health officials, even philanthropists, would join.

Although in his process for condensed milk Gail Borden heated milk to 136 degrees, and thus unknowingly "pasteurized" it, he based his patent application not on the destruction of pathogenic organisms, but on the exclusion of air during manufacture. Air, he believed, contaminated the milk. Pasteur, at this time, was of the same opinion; between 1857 and 1862 he proved that the souring of milk was due to microbes, which he believed came from the atmosphere. His discovery that heating milk would destroy these organisms, and postpone souring, was presented in a report before the Scientific Society at Lille, France, in August, 1857. Simultaneously, Dr. Michael Taylor, in England, announced the first evidence that contaminated milk might spread disease — in this case, typhoid.

From 1860 to 1864 Pasteur investigated the causes of spoilage in French wines, demonstrating that heating to 55 or 60 degrees Centigrade would prevent fermentation by bacteria. In 1870, he developed a process of "pasteurization" for beer. Meanwhile, Pasteur's contemporary, Robert Koch, was uncovering dramatic new evidence of the role of bacteria in disease, and in 1881 introduced the solid culture media which, for the first time, made it possible to trace and identify disease bacteria. That same year, Hart, in London, published the results of his studies of milk-borne epidemics, confirming Taylor's earlier work, and adding

scarlet fever to the list of diseases capable of being transmitted by contaminated milk.

In their efforts to promote a pure and safe milk supply, health authorities during this period were hampered by a lack of clear-cut evidence of the causes of milk-borne diseases; fluid milk distributors were similarly hampered by the absence of commercially-feasible equipment for processing. A bill introduced in the New York legislature in 1861, forbidding the sale of "impure, adulterated or unwholesome milk," was defeated. A similar bill that passed a year later was upset by the courts, who found that the addition of ice to milk was not legally adulteration. Not until 1896 was there any reference to bacteria in the milk reports of the New York City Board of Health.

The first commercial pasteurizer, made by Ashborn, appeared in Germany in 1880; a Danish heater a few years later. By 1885, market milk was being pasteurized regularly — for commercial rather than public health reasons — in Copenhagen and Stockholm. But in America, fresh milk was raw milk. Echoes of alarm at the dangers of infected milk rumbled to these shores with the publication in 1886 of Franz von Soxhlet's findings on the survival rate of infants fed sterilized milk, and a storm of controversy broke. Proponents of pasteurization and sterilization pointed to the dramatic drop in incidents of milk-borne diseases where "rectified" milk was used. Opponents cited the loss of flavor and the burned taste of boiled, or almost boiled, milk; mourned the supposed destruction of its nutrient qualities; proclaimed that pasteurization would serve as a cover-up for milk produced, processed or distributed under unsanitary conditions.

One of the opponents' arguments was valid; boiling made milk virtually unpalatable, useful only, from a commercial standpoint, for infant feeding. Pasteurization was more mode than process, with almost as many methods as there were practitioners. The fault, of course, lay in the equipment. Machinery then on the market employed temperatures of from 160 to 180 degrees, and holding periods of from 20 to 30 minutes. J. H. Monrad's suggestion, in 1895, of a standard holding method of 30 minutes, went unnoticed for a number of years.

But from the laboratory and farm, clinic and city plant, overwhelming evidence of the need for safe milk, and methods for achieving it, began to accumulate. In 1891, the Walker-Gordon Laboratories were organized in Boston with the cooperation of leading physicians of the Harvard Medical School. Walker-Gordon's purpose was to offer a milk, principally for infant feeding, whose production and processing were controlled from cattle feed onward. In 1892, William T. Sedgwick conducted the first bacterial analyses of a city milk supply — that of Boston. During the same year, Dr. Henry L. Coit, of Newark, N. J., drew up a list of 70 sanitary specifications for the production and processing of fluid milk. To the Practitioners' Club in Newark he proposed that county medical societies should appoint medical milk commissions which would enforce

these requirements, and certify the purity of milk produced according to them. This was the birth of "certified" milk, first produced in 1893 by Stephen Francisco at Caldwell, N. J., and approved by the medical milk commission of the Essex County Medical Society.

Progress toward a mass supply of safe milk, meanwhile, was being achieved more slowly. Von Soxhlet's patented method for sterilizing milk in bottles had attracted the attention of Dr. Abraham Jacobi, of New York, who, thirteen years earlier, in 1873, had publicly proposed the boiling or cooking of all milk used in infant feeding. Jacobi's efforts, and those of another apostle of sterilized milk, Dr. Caille, in behalf of von Soxhlet's method, won the backing of the philanthropist, Nathan Straus, who had lost a child from milk-borne diphtheria. In 1893, with Jacobi, Caille, and Dr. Rowland G. Freeman as advisors, Straus opened the first of his noted milk stations on New York's Lower East Side. Only pasteurized milk was distributed to the needy, but it was free, and they used it.

The cause of pasteurization received a serious, but momentary, setback in 1894, when a prominent and respected German scientist, Karl Flugge, declared that the process was harmful to the nutritive properties of milk. But Dr. Theobald Smith's subsequent discovery that pasteurization destroyed the bacilli of tuberculosis present in milk, and the studies of Park and Holt showing a dramatic drop in the death rate of tenement children fed pasteurized milk, diminished the force of Flugge's arguments. And the pioneer work of Rowland, on the effects of heat on milk proteins, virtually nullified Flugge's findings.

Despite the efforts of Straus, Jacobi, and a few milk distributors who began offering pasteurized milk about 1902, there remained a sharp cleavage of opinion on the virtues of, or even need for, a pasteurized product. Some prominent medical men backed certified milk as the only truly safe milk, or, conceding the merits of pasteurization, advocated that it be conducted only under medical supervision, either by the doctor himself, or by the mother in the home. Improved pasteurizing equipment, however, and the standardizing of time and temperature requirements for the process, soon quieted concern over commercial pasteurization. Comprehensive studies of milk in relation to public health were conducted by special commissions appointed in 1907; one in New York City under Dr. Jacobi; another by the U. S. Public Health Service, under its director, Dr. M. J. Rosenau. Both men were advocates of pasteurization, Jacobi as a result of his work with Straus, and Rosenau as a result of his research on the thermal death points of various bacteria. It was a consequence principally of Rosenau's findings that pasteurization was standardized as a process in which milk was heated to 145 degrees, held for 30 minutes, and then cooled. Studies in 1921, under the direction of Dr. Charles E. North, confirmed the adequacy of the process, which was to remain virtually unchanged and in widespread use until the introduction of the "high-temperature — short-time" pasteurizer many years later.

Finally, the struggle was being resolved. In 1908, New York City's Sanitary Code was amended to include regulations for pasteurization. Chicago, in 1909,

became the first city to require the pasteurization of all market milk not coming from tuberculin tested cows. New York City, following an outbreak of milk-borne typhoid fever, in 1914 ordered the pasteurization of all milk except certified. The final barrier fell when, in June, 1935, the American Association of Medical Milk Commissions approved the permissive pasteurization of certified milk.

Thrilling evidence of how far science and industry have progressed over a century in their fight for safer milk is the almost universal use of pasteurized milk in unheated manufactured products. Ice cream comes from a pasteurized mix, and "Made from pasteurized sweet cream" is stamped on every trade-marked carton of butter. It is now "pasteurized cream cheese." The processes used in manufacturing provide the safeguards for condensed and evaporated milk, and milk powders. Gail Borden, proud and prophetic though he was, could not have dreamed his endowment.

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Homogenization, another of the great inventions in the milk industry during the past century, had a history of development and application almost as long and painful as that of pasteurization. But whereas pasteurization suffered from the barbs of its opponents, homogenization withered under the snake-oil claims of its early advocates. In 1909, one enthusiastic proponent recommended homogenized milk for bottle babies suffering from gastroenteritis, cholera infantum, and ringworm, and for adults afflicted with dyspepsia, jaundice, measles, Bright's disease, kidney and liver diseases, "excesses or the abuse of alcoholic liquors," and "all kinds of poisoning, acute or chronic." So outrageous were the claims over so long a period that H. A. Harding as late as 1938 was lamenting the fact that "Homogenization has suffered more from its friends than from any other cause."

Homogenization entered the world of dairying with a bar sinister: a Frenchman, Paul Marix, was granted two patents in 1892 for a process for manufacturing margarine. Marix, however, and his immediate contemporary, Julien, were concerned with rendering an artificial mixture homogeneous. No thought was given to making a stable emulsion out of a natural emulsion such as milk. To A. Gaulin, also a Frenchman, goes credit for this innovation, and, through subsequent patents, for the process of homogenization much as we know it in the dairy industry today.

Milk treated by Gaulin's process (patented in 1899) was exhibited at the World's Fair at Paris in 1900, and attracted much curiosity. Gaulin, himself, however, recognized the imperfections of his method, and began an intensive study of the physical structure of milk. He noted, for example, that the largest fat globules were 500 to 600 times *smaller* than the apertures they were being forced through. His eventual solution: crushing the heated liquid, as it emerged from the openings, uniformly against a smooth surface under great pressure.

Gaulin's homogenizer of 1909 underwent little change in design for the next quarter of a century. Improvements were in the sanitization of equipment, notably the introduction of the completely demountable homogenizer in the 1930's. Varieties of the single-service valve made their appearance in 1940, 1947, and 1948, each claiming to improve the efficiency of homogenization or to lower the required pressure — but each also providing a more uniform distribution of milk against the "crushing" surface, a principle enunciated by Gaulin back in 1902.

Though mechanical changes in homogenizing equipment were minor and few, cumulative commercial experience with, and impressive literature on, the process and resulting products were being gathered. Data on sequences of homogenization, and on flavor stability, rancidity, sedimentation, soft curd, nutritive value, and physical qualities were being collected at Agricultural Experiment Stations, the U. S. Department of Agriculture, and the Dominion Department of Agriculture at Ottawa, Canada. By the time of World War I, homogenization was prevalent in the evaporated milk industry. The first commercially successful homogenized fresh milk was introduced by The Borden Company in Ottawa in 1927, and by the McDonald Dairy Company in Flint, Michigan, in 1932. At present, well over half the fresh milk sold in the United States is homogenized, much of it fortified with Vitamin D.

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The spotlight that played upon fluid milk for some three quarters of a century, from 1870 onward, cast into the shadows, at least so far as the public seemed aware, most of the other important development within the dairy industry during that period. Geneticists, physiologists, animal husbandmen, veterinarians, biochemists, even climatologists were taking advantage of the adaptable nature of the dairy cow to produce hardier, healthier and more productive breeds. Public health authorities, with the cooperation of men in industry, were codifying practical and effective sanitary regulations for farm and plant. Inventive minds were discovering new devices, techniques and processes. Some of these, like the Babcock tester, Gaulin's homogenizer, Meyenberg's evaporated milk, the roller and spray methods for drying milk, filled immediate and specific needs in the industry. Other advances — stainless steel, mechanical refrigeration, automotive transport — eventually contributed significantly to making today's incredibly complex dairy industry so remarkably efficient.

In their efforts to improve the quality and quantity of the milk supply, scientists did not overlook even the cow herself. History, of course, was studded with evidence of the cow's adaptability; the Brahma on the searing plains of India, and the *Bos Longifrons* of Western Europe, were functioning efficiently for their clime hundreds of years before Christ. What limitations they had as milk producers were perhaps more than offset by their ability to forage for food, since confirmation of the effect of feeds on output was to come many centuries later. The introduction of red clover to Great Britain in 1645, one contemporary

writer said, brought more benefit to farmers than all the books written on agriculture.

Several breeds of cows were known in Europe long before the arrival of the first cows in America, at Jamestown in 1611. The early colonists, however, and later settlers of the West, were more concerned with the supply of milk and meat than with the development of good breeding and feeding practices with dairy cattle. Cows waxed fat on the abundant wild green grasses, and if their owners were ignorant of proteins and anti-scorbutic and fat-soluble vitamins, they nonetheless found the milk good and plentiful. By the 1850's however, American dairy herds, with a few notable exceptions, had become a scrubby and indeterminate lot. Poor feeding and poor breeding, together with poor sanitation, dammed the flow of wholesome milk.

The earliest attempt to work out equivalents for feed, these in terms of hay, dates from about 1810, with the published studies of Thayer in Germany. The first of the feeding standards, as they are known today, was proposed by Grouven in 1858. But it was Gail Borden who was perhaps first to combine scientific feeding methods with sanitary requirements in the production of market milk. In addition to his "Dairymen's Ten Commandments" — udders washed before milking, sterilized strainers and others — he recommended the addition of cotton seed meal to the dairy ration. In his journals he noted gleefully that output of the 600 cows of his suppliers had increased 25 per cent. Borden, however, was more innovator than biochemist, and less than either of these a dairy farmer, so it is probable he did not observe the effect of his recommended diet on the health of the cows. Not until the mid-1920's would science relate instances of blindness, staggering gait, and eventual death of cows to the carotene-deficiency of high protein supplements.

Much of the progress in the latter decades of the eighteenth century was achieved by trial and error as scientists sought to equate cause with effect, or, more often, effect with cause. Red clover, of more benefit "than all the books on agriculture" when introduced to England in 1645, was identified as a cause of bloat in 1795, but the toxicity of the spoiled grass was still being attributed to "unknown substances" as late as 1906. Proximate analysis of feedstuffs, by the method still essentially employed today, was introduced by Henneberg and Stohmann, in 1860. Stohmann, in 1869, was probably the first to point out that the apparent digestibility of protein increases as the protein content of feed increases. Calculation of the minimum of digestible crude protein required by mature cows occupied the attention of dairy nutritionists for some four decades, until Armsby in 1903 proposed 0.6 pounds per 1,000 pounds of body weight per day, an allowance that is an accepted part of feeding standards today.

A turn in the somewhat sporadic battle against diseases and nutritional deficiencies in dairy cattle came with the passage of the Hatch Act in 1887, under which agricultural experiment stations were established at land grant colleges. Soon, from throughout the length and breadth of America, and, through

informational exchanges, from all parts of the world, came reports of strange syndromes and their relation to dietary deficiencies; reports of new knowledge in the composition and metabolism of feeds. The Vermont Experiment Station, in 1887, was the first to analyze chemically a sample of grass silage, generously provided by a local farmer, and compute its feeding value. (The farmer must have been a progressive one; the first vertical silo in America had been constructed only eleven years before, and the first experimental silos for use by colleges were not to be constructed for another four years.) "Stiffs" and "sweeny," "Lamziekte" and "Lechsucht," "bush sickness" and bone chewing joined the glossary of researchers, and these were traced in time to deficiencies of phosphorus, cobalt, and copper. By 1887, Kuhn had suggested that perhaps cows require two rations, one for maintenance and one for milk production.

Progress by nutritionists during this period in the control and cure of diet-deficiency diseases was being matched by veterinary science in its struggle against infectious diseases. The first to fall before the onslaught of medical science was pleuropneumonia, introduced from England in 1843 and finally declared eradicated in 1892. The scourge of tuberculosis had been known for centuries, but not until Robert Koch discovered the tubercle bacillus in 1882, and introduced tuberculin eight years later, was science equipped with the first of the weapons to fight the disease. Organized measures against bovine tuberculosis were taken up by the Bureau of Animal Industry of the U. S. Department of Agriculture in 1917, and the disease was officially declared virtually eliminated by the close of 1942. Although the national rate of reactors is now only about one-tenth of one percent, the occasional discovery of bovine tuberculosis in dairy herds continues to spur the campaign of Federal and state officials against this disease. Yet, as late as the turn of the twentieth century, cures for other troubling cattle diseases were being conducted in modes reminiscent of the Middle Ages. Bang's disease, or brucellosis, was being treated by feeding carbolic acid or methylene blue to the cows, and the dairy barn that did not reek of one presented the hideous hue of the other. (Strain 19, an organism providing only moderately effective protection against brucellosis, but still the closest approach to immunization, was released for general use only in 1941). Mastitis, now treated with antibiotics, a half-century ago called for the application of hot packs and a drench of salts. No cure was known for milk fever until the early 1930's, when its cause was identified as a calcium deficiency, and progress toward its prevention was delayed until mid-century, at which time two preventive methods were proposed: withholding calcium during the weeks preceding freshening or feeding massive doses of Vitamin D.

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Technical developments, meanwhile, were transforming the amorphous shape of dairying into the sculptured outlines of an enormously intricate and amazingly complex modern industry. The partnership between science and industry drew tighter. Twelve years apart appeared two of the most significant discoveries in

the field of dairy manufacturing: the centrifugal cream separator, in 1878, and the simple butterfat tester, in 1890.

Until the appearance of the continuous cream separator, methods for removing butterfat from milk were slow, cumbersome, and inefficient. With the gravity method, a complex of pans and crocks were required, and the skim milk was often sour by the time the cream had been removed.

Like so many other inventions that have changed the face of dairying, the mechanical separator entered the industry by indirection. Its originator, Dr. Carl De Laval, had invented a turbine engine, and had applied it as the power source in the centrifugal separation of foreign substances from metals. Later, he used the principle in the separation of cream from milk, placing his device on the market in Sweden in 1878. Several hundred patents have been taken out for the De Laval centrifugal, each improving its efficiency or capacity. The De Laval Separator Company now claims that 90 per cent of all centrifugals in U. S. dairy plants are of its manufacture.

The percentage of butterfat in cream was now in the hands of the operator who controlled a De Laval separator. The percentage of butterfat in milk, however, was still determined by the cow, and there was no way to measure the richness of her product except to churn a cream sample in a glass tube — a crude and unreliable method. Dairymen had no great monetary incentive to breed better herds, since their milk, particularly for creameries, was being mixed with that of marginal producers. Butter and cheese manufacturers, and even distributors of fluid milk, could not easily distinguish between rich and thin milk, and often paid on the assumption that it was the latter. Health authorities were hampered in their efforts to define standards, and the consumer, potential victim of all this ignorance, placed his faith in the integrity of the supplier.

Then, in 1890, Stephen M. Babcock, working at the University of Wisconsin, came forth with his simple butterfat test, and his simple butterfat tester.* Here, at last, were method and equipment simple enough for the most inexperienced dairyman to use; accurate enough for the most up-to-date dairy. His discoveries permanently altered the forward course of the American dairy industry: butterfat became the one element common to every phase of the industry, the one to which the price structure of this multi-billion dollar enterprise has been geared, the one which provides the basic economic incentive for the mass of dairy farmers to continue in business.

As the dairy industry expanded, so, too, did the roster of scientists, inventors, and industrialists who contributed to its growth. Sequence and consequence became indistinguishable.

Mechanical refrigeration is indispensable to the dairy industry as we know it today. Yet it is only a little more than a century since a physician in Appalachicola, Florida, in 1845, invented the "artificial ice machine." Linde, in Germany,

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*Nicholas Gerber, a Swiss, invented a butterfat tester in 1888 that is still officially in use in Europe. His method, however, was published in 1891.

and Boyle, in the United States, produced the first commercially successful ammonia compression refrigeration machines about 1875. In the ice cream field, ice and salt as industrial refrigerant gave way to Edward Walker's brine freezer in 1900. The Nizer ice cream cabinet and dry ice appeared in 1923. Kelvinator introduced the home refrigerator; General Motors' freon gas supplanted ammonia.

Nancy Johnson, in 1846, invented the hand-cranked freezer for ice cream. James Madison Horton added steam power in 1870. Electricity entered in 1889. The direct expansion batch freezer appeared in 1920, to be followed by the continuous process freezer, the Vogt Instant Freezer, in 1928.

Who can evaluate the rightful place in dairy industry history of the ice cream cone (1904), the ice cream sundae (1885 or 1897), Epperson's "Epsicle" (later Popsicle), or the Eskimo Pie? Bloomer Bros. Co.'s tape-handled ice cream pails at the turn of the 20th century became the forerunner of the industry's sleek line of packaged products. The single-service paper cans for bulk ice cream, introduced in the 1920's, spelled the end for heavy, cumbersome, hard-to-clean tins.

John Meyenberg, in 1884, received a patent for his process of steam-sterilizing unsweetened condensed milk in cans — the product we now know as evaporated milk. Its system of manufacture remained virtually unchanged for almost 40 years, until the introduction of the continuous system of sterilization on a limited scale in 1922. Cans for evaporated and condensed milk were made by hand until 1901. Tubular, and double and triple effect vacuum pans replaced the simple device Gail Borden had copied from the Shakers, and whereas his was made of copper, these were made of stainless steel. Gail Borden's first cans of condensed milk were filled by hand from an old molasses faucet. Modern equipment can fill — and sterilize — more than 200 cans of evaporated milk each minute.

America's first commercially successful dry milk plant went into operation in 1903, using an atmospheric roll drier developed by the Merrell-Soule Company. A plant using a vacuum drum drier, operated by the Ekenberg Company, opened in 1905. Merrell-Soule began the first successful spray process milk drying plant in 1906. Thus, within a three-year period, the foundation was laid for a subsequent half-century of development in milk powder processing. Introduction of consumer-packaged nonfat dry milk in the early 1940's and its subsequent improvement in "instant" form through the Peeble's and other processes, have made the product of major importance in the dairy industry.

Until Jesse Williams opened the first commercial cheese factory in America at Rome, N. Y., in 1851, cheese making was a family affair. Williams' factory produced the familiar Cheddar, but by 1858 Swiss settlers in upstate New York had added a new variety — Limburger. America's first Swiss cheese originated in a Swiss colony near Alliance, Ohio. Nicholas Gerber, in 1869, opened the first farmers' factory for making Swiss cheese in Green County, Wisconsin, now known as the "Swiss Cheese Capital" of the U. S. The first "native" cheese, Brick, is credited to John Jossi, who in 1865 was attempting to make Backstein,

a cheese of German origin. In 1880 came the first American Camembert, produced by Louis Cantel, of Petaluma, California; in 1881, the first American cream cheese, made by W. A. Lawrence in Chester, N. Y. Emil Frey, an apprentice, accidentally discovered a new kind of cheese in 1892, and branded it Liederkranz.

A major transformation in the American cheese industry came in 1921 with the introduction of pasteurized process cheese, developed by J. L. Kraft. Nationally advertised and marketed, the product had a pronounced effect on national cheese consumption. Requiring no refrigeration, consistent in flavor and texture, it caught the popular fancy and soon was being sold in a variety of shapes and sizes. Other types of cheeses joined a growing list: cold pack Cheddar, "club" cheeses with smoked flavor, cheese foods. When World War II cut off imports of Roquefort and Bleu cheeses, American cheesemakers began making blue cheese of good quality. America's newest native cheese is a mold cheese — Nuworld, developed at the University of Wisconsin.

Machinery and equipment, new packaging materials, and new chemical knowledge kept pace with the rapid growth of the cheese industry. The first Cheddar cheese sealed in cans appeared in 1904. Films and foils as wrappers attracted attention in the early 1920's. The first commercial package covered with cellophane and wax was patented in 1933. Jars became popular as containers for process cheese in the early 1930's. Slicing machinery and gas-packing equipment, and mold inhibitors, brought a return of natural cheeses to popular favor in the 1950's.

In the fluid milk industry, progress grew apace. Harvey Thatcher's flint glass bottle with its nickel-plated closing bail gave way to the pressure of scores of innovations and improvements. The green glass became clear; the bottle was ridged, fluted, knobbed, made square, given an hour-glass shape; the tops were made of paper, or cardboard, given inner seals and outer hoods, tied down with wire. In the 1940's, the amber bottle supplanted the clear bottle for multi-fortified milk, to protect light-sensitive vitamins.

In 1929 appeared the first paper container, the Sealcone. Shortly after came the reinforced paper "bottle," designed to be filled on a standard glass bottle filler. Next were the Dixie-Vortex, the Reed circular, and the Perga. By 1938 the familiar square-bodied container had evolved. These containers, made by American Can Company and Ex-Cell-O Corporation, now account for about 90 percent of the paper milk containers in use. The latest innovation is the Tetra Pak, pyramid-shaped containers made from a continuous roll of paper and formed as they enter the filling machine.

As an art, buttermaking dates back 4,000 years; as an industry, it is just a century old. The first creamery in the United States was established in Orange County, N. Y., in 1856. The factory system of buttermaking, however, was slow to take hold, barely penetrating west of the Mississippi before 1890. True, output of creamery butter jumped 30-fold in the 25-year period after the opening

of the first factory, but production of some 30 million pounds in 1880 was only about four per cent of that made on farms.

If the factory system did not take the butter industry by storm, it was not for lack of effort on the part of those who supported the system. Patents on butter churns were being issued by the U. S. Patent Office at the rate of one a fortnight; commercial mechanical refrigeration was welcomed, as were Babcock's and Gerber's testers, the De Laval separator, the centrifugal hand separator, and, finally, in 1892, the combined churn and worker. One of the most significant factors in the establishment of the creamery industry in all sections of the United States was the introduction of the "centralizer" system of buttermaking in 1895. Skimming stations were set up for the factory separation of milk. Pasteurization of cream came to the butter industry in 1896, under the aegis of the University of Wisconsin.

Then, about the turn of the century, a paradox overtook the butter industry, wherein the growth of efficiency brought a return of old-time methods. With the introduction of factory separation of milk, creameries had grown in size. But as they grew, they became increasingly unable to contend with the foaming of milk during separation. By 1923, most of the butter in the United States was again being produced from farm-separated milk. Engineers eventually solved the foaming problem in two stages: first, with foam-destroying machinery; then, with the invention of the foamless separator about 1933.

Quality, as well as quantity, was the concern of the butter industry during its early stages of development. Until 1890, most of the butter in the U. S. was made from sour cream, giving the product a distinctive flavor that consumers liked and were reluctant to yield when some manufacturers began using sweet cream. The development of effective bacterial cultures about 1890 made possible the production of butter with a controlled flavor, but these cultures were costly and complex and gained little favor. Iowa State College pioneered the manufacture of "neutralized" cream butter about 1906. In 1933, the first synthetic flavoring compounds were introduced, followed two years later by the development of distillates prepared from desirable butter cultures by dairy scientists at the University of Illinois.

Quality was enhanced, too, by technological developments — pasteurizing and cooling equipment from newer metals, reducing the incidence of off flavors resulting from copper and iron salts present in the cream and butter; the development of the all-metal churn in 1932. Greater attention was given also to the quality of milk from which butter was being made, through the introduction of modern equipment for milk handling and cream separation. A milestone in the quality improvement of butter was the passage of the Federal Food, Drug and Cosmetic Act in June, 1938.

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The growth of the dairy industry owes much, too, to the development of efficient transportation. Borden sold his condensed milk door-to-door from a

wooden pushcart; Sheffield drove a horse and wagon; Hood met his milk train at the freight yard. As the transportation industry provided the tools, the dairy industry adapted them to its needs.

For eighty years, milk traveled mostly in a ten-gallon can in its trip from farm to pick-up point, country receiving station, or city depot. Then, in 1922, the first railroad tank car for transporting milk from receiving station to city processing plant was introduced by The Borden Company. As automotive transport and overland highways developed, the tank car design was adapted (about 1915) to truck bodies; in 1940, a marriage of the two took place: railroad tanks that could be transferred to trucks at the freight yard, moved through the streets to city pasteurizing plant.

The milk wagon, with its horse who knew the stops as well as the driver, is a boyhood memory of many young adults, yet the first step-and-drive milk truck dates to 1925. The gasoline shortages of World War II resurrected Dobbin for a moment of glory and nostalgia, but the wagon was never quite the same, square-edged, silent, and soft-tired.

To speed milk from farm to city plant, the country receiving station was bypassed. The Dairymen's League Cooperative Association, Inc., in the late 1940's, began delivery of farm milk in 40-quart cans by refrigerated trailers. At the same time, bulk-tank pickup of farm milk caught hold.

In the 1950's, the larger dairies introduced fleets of refrigerated home delivery trucks. To service suburban areas, some dairies later devised the "detached unit," a number of home delivery trucks supplied at a central point from a "mother" truck loaded at the city pasteurizing plant.

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The record of progress in the dairy industry during the past century bears the imprints of many men and events, and in attempting to distinguish among them the historian perhaps blurs them all. But remaining sharp and clear after a hundred years is the mark left by the partnership of science and industry which, in resolving nature's paradox, made of milk a friend of man.

—MAURICE J. O'REILLY
The Borden Company

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